(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 301 575 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **88112341.8**

(51) Int. Cl.4: **H05B 6/80**

(22) Date of filing: **29.07.88**

(30) Priority: **31.07.87 JP 192934/87**

(43) Date of publication of application:
01.02.89 Bulletin 89/05

(84) Designated Contracting States:
DE FR GB IT SE

(71) Applicant: **Matsushita Electric Industrial Co., Ltd.**
1006 Oaza Kadoma
Kadoma-shi Osaka(JP)

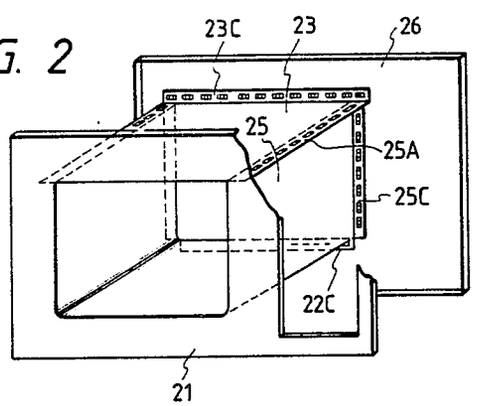
(72) Inventor: **Tanaka, Yuji**
390, Asa-machi
Gose-shi Nara-ken(JP)
Inventor: **Nagao, Shuji**
5-4-70-62, Kikyogaoka
Nabari-shi Mie-ken(JP)
Inventor: **Nakagawa, Takeshi**
Heijo Daini Danchi 62-505, 2-2 Ukyo
Nara-shi Nara-ken(JP)
Inventor: **Ono, Tetsuji**
3-1-44-405, Kataokadai Kanmaki-cho
Kita Katsuragi-gun Nara-ken(JP)

(74) Representative: **Dipl.-Phys.Dr. Manitz**
Dipl.-Ing.Dipl.-Wirtsch.-Ing. Finsterwald
Dipl.-Phys. Rotermund Dipl.-Chem.Dr. Heijn
B.Sc.(Phys.) Morgan
Robert-Koch-Strasse 1
D-8000 München 22(DE)

(54) Heating box for a microwave oven.

(57) A heating box has an interior exposed to microwave. The heating box includes a first metal panel and a second metal panel. The first panel has a join portion. The second panel has a join portion which opposes and contacts the join portion of the first panel. The first panel and the second panel are bonded together at the join portions thereof. A plurality of electrical connections between the first and second panels extend in the join portions of the first and second panels. The electrical connections are spaced.

FIG. 2



EP 0 301 575 A2

HEATING BOX FOR A MICROWAVE OVEN

BACKGROUND OF THE INVENTION

This invention relates to a heating box or an internal box usable in microwave cooking appliances such as a microwave oven or an electronic range. This invention also relates to a method of manufacturing such a heating box.

General microwave ovens have a casing which accommodates a heating box or an internal box. The heating box is usually required to have an adequate mechanical strength. In addition, it is desirable that the heating box effectively prevents a microwave leakage.

SUMMARY OF THE INVENTION

It is a first object of this invention to provide a strong heating box.

It is a second object of this invention to provide a heating box which can effectively prevent a microwave leakage.

It is a third object of this invention to provide a simple method of manufacturing a heating box.

A heating box of this invention includes a first metal panel and a second metal panel. The first panel has a join portion. The second panel has a join portion which opposes and contacts the join portion of the first panel. The first panel and the second panel are bonded together at the join portions thereof. A plurality of electrical connections between the first and second panels extend in the join portions of the first and second panels. The electrical connections are spaced.

In a method of manufacturing a heating box according to this invention, a join portion of a first panel and a join portion of a second panel are brought into contact with each other. Each of the first and second panels has a metal wall and a non-metal coat fixedly extending on a surface of the metal wall. The metal walls of the join portions of the first and second panels are separated by the non-metal coats. The first and second panels are cut along two parallel lines extending in the join portions of the first and second panels. Parts of the first and second panels between the cut lines are forcedly displaced in a direction along thicknesses of the first and second panels. The displaced parts of the first and second panels are pressed and are thereby expanded along directions parallel to the join portions of the first and second panels to form a mechanical connection between the first and second panels and also to directly contact the metal walls of the first and second panels to form electrical connections between the first and second panels which extend at respective corners of the mechanical connection.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded perspective view of a heating box according to a first embodiment of this invention under conditions which occur before processes of bonding panels are performed.

Fig. 2 is a perspective view of the heating box of the first embodiment under conditions where the panel bonding processes were completed and the heating box was assembled.

Fig. 3 is a perspective view of a portion of the heating box of Fig. 2.

Figs. 4 and 5 are sectional views of a portion of the heating box of Fig. 2 and devices for producing the bonding section of Fig. 3.

Fig. 6 is a sectional view taken along the line L6-L6 of Fig. 5.

Fig. 7 is a perspective view of the punch of Figs. 4-6.

Fig. 8 is a perspective view of the combination of the jaws, the spring, and the die of Figs. 4-6.

Fig. 9 is a sectional view taken along the line L9-L9 of Fig. 3.

Fig. 10 is a plan view of the bonding section of Fig. 9.

Fig. 11 is a sectional view taken along the line L11-L11 of Fig. 3.

Fig. 12 is a perspective view of a portion of a heating box according to a second embodiment of this invention.

Fig. 13 is an exploded perspective view of a heating box according to a third embodiment of this invention under conditions which occur before processes of bonding panels are performed.

Fig. 14 is a perspective view of the heating box of the third embodiment under conditions where the panel bonding processes were completed and the heating box was assembled.

Fig. 15 is a perspective view of a portion of the heating box of Fig. 14.

Fig. 16 is a sectional view taken along the line L16-L16 of Fig. 15.

Fig. 17 is a plan view of the bonding section of Fig. 16.

Fig. 18 is a sectional view taken along the line L18-L18 of Fig. 15.

DESCRIPTION OF THE FIRST PREFERRED EMBODIMENT

With reference to Figs. 1 and 2, a heating box or an internal box of a microwave oven includes a front panel 21, a floor panel or a lower panel 22, an upper panel 23, opposing side panels 24 and 25, and a rear panel 26.

The lower panel 22 and the side panels 24 and 25 are integral with each other, forming a U-shaped member. The side panels 24 and 25 are fixed or bonded to the upper panel 23 via flanges 24A and 25A formed on upper edges of the side panels 24 and 25 respectively. The lower panel 22, the upper panel 23, and the side panels 24 and 25 are fixed or bonded to the front panel 21 via flanges 22B, 23B, 24B, and 25B formed on front edges of the panels 22, 23, 24, and 25 respectively. The lower panel 22, the upper panel 23, and the side panels 24 and 25 are fixed or bonded to the rear panel 26 via flanges 22C, 23C, 24C, and 25C formed on rear edges of the panels 22, 23, 24, and 25 respectively. The flanges of the panels 22-25 form join portions opposing and contacting portions of the panels 21, 23, and 26 which define corresponding join portions.

The panels 21-26 are connected in the form of a box. The panels 22-26 define an internal space or a cooking chamber of a rectangular parallelepiped which is exposed to microwaves. The front panel 21 has a rectangular opening 21D in communication with and in register with the cooking space.

The panels 21-26 are composed of coated steel plates such as coated stainless steel plates or laminate steel plates having coats of resin. Each of the steel plates forming the panels 22-26 has opposite surfaces coated and uncoated respectively. The panels 22-26 are arranged so that coats on the panels 22-26 oppose the cooking space. In other words, the cooking space is defined by the coated surfaces of the panels 22-26. The outer surfaces of the panels 22-26 have no coat.

The connections between the panels 21-26 are designed and performed in similar manners. The connection between the upper panel 23 and the rear panel 26 will be described in more detail hereinafter.

As shown in Fig. 3, the flange 23C of the upper panel 23 contacts the rear panel 26. The upper panel 23 and the rear panel 26 are fixed together at rectangular recessed bonding sections 31 extending in the flange 23C of the upper panel 23 and the corresponding part of the rear panel 26. The bonding sections 31 are spaced at equal pitches P in a longitudinal direction of the flange 23C. The pitch P between the bonding sections 31 is preferably smaller than a quarter wavelength of microwave used in the oven. As will be made clear hereinafter, the bonding sections 31 are formed in a method including a cutting process, a drawing process, and a forced plastical deformation process.

During the formation of the bonding sections 31, as shown in Fig. 4, the flange 23C of the panel 23 and the panel 26 are brought into contact and then the flange 23C of the panel 23 and the corresponding part of the panel 26 are sandwiched between a holder 41 and jaws 42. A metal wall 23Y of the flange 23C of the panel 23 and a metal wall 26Y of the panel 26 are separated by a coat 23Z of the panel 23 and a coat 26Z of the panel 26. Under the conditions of Fig. 4, the coats 23Z and 26Z prevent electrical connection between the panels 23 and 26. The holder 41 accommodates a punch 45. As shown in Fig. 7, the punch 45 has a trapezoidal working end. As shown in Figs. 4 and 8, the jaws 42 are supported on a die 47 and are mutually connected via a spring 44. The jaws 42 are rotatable about a roll pin 43. The jaws 42 are normally held by the spring 44 in positions where the jaws 42 form a cylinder whose end has a diametrical groove 42A. As shown in Figs. 5 and 6, the punch 45 is moved downward against the force of a spring 46, meeting the panels 23 and 26 and cutting them along lines corresponding to longer sides of a rectangle of each bonding section 31. During the downward movement, the punch 45 bends downward the portions of the panels 23 and 26 corresponding to shorter sides of the rectangle of each bonding section 31 and also displaces downward portions 23E and 26E of the panels 23 and 26 between the cut lines. After the displaced portions 23E and 26E of the panels 23 and 26 reach positions extending downward of the rest of the panels 23 and 26, the displaced portions 23E and 26E of the panels 23 and 26 are pressed between the punch 45 and the die 47. This pressing process plastically deforms the displaced portions 23E and 26E of the panels 23 and 26 and expands them outward along directions parallel to the flange 23C of the panel 23 and the panel 26. As the displaced portions 23E and 26E of the panels 23 and 26 expand outward, the jaws 42 rotate outward about the roll pin 43 against the force of the spring 44. The displaced portions 23E and 26E of the panels 23 and 26 are thus made larger in width than the opening of the rest of the panels 23 and 26 between the cut lines. Edges of the displaced portion 26E of the panel 26 engage the non-displaced portion of the panel 23, producing mechanical bonding between the panels 23 and 26 and thus preventing separation between the panels 23 and 26.

As shown in Fig. 9, in the bonding section 31, the cut opening in the non-displaced portions of the panels 23 and 26 has a width A. The portions 23E

and 26E of the panels 23 and 26 were displaced by a distance D corresponding to a depth of the cut opening. The displaced and deformed portions 23E and 26E has a width B and a thickness C. The non-displaced portion of the panel 23 has a thickness t1. The non-displaced portion of the panel 26 has a thickness t2. The width B of the displaced and deformed portions 23E and 26E of the panels 23 and 26 is preferably chosen so as to satisfy the following relationship.

$B \geq A + \{2(t1 + t2)/3\}$

The thickness C of the displaced and deformed portions 23E and 26E of the panels 23 and 26 is preferably chosen so as to satisfy the following relationship.

$C \leq 0.8(t1 + t2)$

The depth D is preferably chosen so as to essentially equal to the sum of the thicknesses t1 and t2.

As shown in Figs. 10 and 11, the bonding section 31 has a recessed structure having a pair of sides 31A and 31B and a rectangular flat bottom 31C defined by the displaced and deformed portions 23E and 26E of the panels 23 and 26. The bottom 31C extends between the sides 31A and 31B. The sides 31A and 31B connect the bottom 31C and the non-displaced portions of the panels 23 and 26. The sides 31A and 31B slope at an angle of 45°. The bottom 31C has a length E. At respective corners of the rectangle of the bonding section 31, the metal wall of the panel 23 and the metal wall of the panel 26 are held in direct contact so that electrical connections 31D between the panels 23 and 26 are produced. Each of the electrical connections 31D has an effective area equal to the value "t1Xt2". As shown in Fig. 10, the distance between the electrical connections 31D in a common longer side of the rectangle of the bonding section 31 is equal to the value "E+2t1".

The structure of the bonding sections 31 allows reliable mechanical connections between the panels 21-26 so that the heating box can be strong. The electrical connections 31D in the bonding sections 31 are in two parallel lines extending along each of the flanges of the panels 22-25. The larger distance between the adjacent electrical connections 31D in a common line is smaller than a quarter wavelength of microwave used in the oven. These designs of the electrical connections 31D effectively prevent the leakage of the microwave from the cooking space.

DESCRIPTION OF THE SECOND PREFERRED EMBODIMENT

Fig. 12 shows a second embodiment of this invention which is similar to the embodiment of Figs. 1-11 except for the following design change.

In the embodiment of Fig. 12, bonding sections 31 are alternately separated into two groups. The cut lines in the bonding section 31 in the first group are perpendicular to the cut lines in the bonding section 31 in the second group. This arrangement improves the strength of connections between panels.

DESCRIPTION OF THE THIRD PREFERRED EMBODIMENT

Figs. 13-18 show a third embodiment of this invention which is similar to the embodiment of Figs. 1-11 except for design changes indicated hereinafter. A heating box of the third embodiment is designed for a microwave oven equipped with a heater.

As shown in Figs. 13 and 14, an auxiliary plate 51 is placed on an upper plate 23. In addition, an inner rear panel 52 is placed between an outer rear panel 26 and each of panels 22-25.

The connections between the panels 21-26, and 52 are designed and performed in similar manners. The connection between the side panel 25, the inner rear panel 52, and the outer rear panel 26 will be described in more detail hereinafter.

As shown in Fig. 15, an edge of the panel 52 is sandwiched between the panel 26 and the flange 25C of the panel 25. The panels 25, 26, and 52 are fixed together at rectangular recessed bonding sections 31 extending in the flange 25C of the panel 25 and the corresponding parts of the panels 26 and 52. The bonding sections 31 are spaced at equal pitches P in a longitudinal direction of the flange 25C. The pitch P between the bonding sections 31 is preferably smaller than a quarter wavelength of microwave used in the oven. The bonding sections 31 are formed in a method similar to the method in the embodiment of Figs. 1-11.

As shown in Fig. 16, in the bonding section 31, a cut opening in non-displaced portions of the panels 25, 26, and 52 has a width A. Portions 25E, 26E, and 52E of the panels 25, 26, and 52 were displaced by a distance H corresponding to a depth of the cut opening. The displaced and deformed portions 25E, 26E, and 52E has a width F and a thickness G. The non-displaced portion of the panel 25 has a thickness t1. The non-displaced portion of the panel 52 has a thickness t2. The non-displaced portion of the panel 26 has a thickness t3. The width F of the displaced and deformed portions 25E, 26E, and 52E of the panels 25, 26, and 52 is preferably chosen so as to satisfy the following relationship.

$F \geq A + \{2(t1 + t2 + t3)/3\}$

The thickness G of the displaced and deformed portions 25E, 26E, and 52E of the panels 25, 26, and 52 is preferably chosen so as to satisfy the following relationship.

$G \leq 0.8(t1 + t2 + t3)$

The depth H is preferably chosen so as to essentially equal to the sum of the thicknesses t1, t2, and t3.

As shown in Figs. 17 and 18, the bonding section 31 has a recessed structure having a pair of sides 31A and 31B and a rectangular flat bottom 31C defined by the displaced and deformed portions 25E, 26E, and 52E of the panels 25, 26, and 52. The bottom 31C extends between the sides 31A and 31B. The sides 31A and 31B connect the bottom 31C and the non-displaced portions of the panels 25, 26, and 52. The sides 31A and 31B slope at an angle of 45°. The bottom 31C has a length E. At respective corners of the rectangle of the bonding section 31, electrical connections 31D between the panels 25, 26, and 52 are produced. Each of the electrical connections 31D has an effective area equal to the value "{t1Xt2+t3-(t1+t2)}".

Claims

1. A heating box whose interior is exposed to microwave, the heating box comprising:
a first metal panel having a join portion;
a second metal panel having a join portion which opposes and contacts the join portion of the first panel;
means for bonding the first and second panels together at the join portions thereof; and
a plurality of electrical connections between the first and second panels, the electrical connections being spaced and extending in the join portions of the first and second panels.

2. The heating box of claim 1 further comprising a plurality of mechanical connections between the first and second panels, the mechanical connections being close to the electrical connections.

3. The heating box of claim 2 wherein each of the mechanical connections extends between an adjacent pair of the electrical connections.

4. The heating box of claim 1 wherein the join portion of the first panel extends along a side of the first panel, and the electrical connections are in at least two lines extending along the side of the first panel.

5. The heating box of claim 1 wherein at least one of the first and second panels has a coat at a surface facing inward with respect to the box.

6. The heating box of claim 1 wherein the electrical connections are composed of thickness portions of the first and second panels.

7. A method of manufacturing a heating box, comprising the steps of:
contacting a join portion of a first panel and a join portion of a second panel, wherein each of the first and second panels has a metal wall and a non-metal coat fixedly extending on a surface of the metal wall, and wherein the metal walls of the join portions of the first and second panels are separated by the non-metal coats;
cutting the first and second panels along two parallel lines extending in the join portions of the first and second panels;
forcedly displacing parts of the first and second panels between the cut lines in a direction along thicknesses of the first and second panels;
pressing and thereby plastically expanding the displaced parts of the first and second panels along directions parallel to the join portions of the first and second panels to form a mechanical connection between the first and second panels and also to directly contact the metal walls of the first and second panels to form electrical connections between the first and second panels which extend at respective corners of the mechanical connection.

FIG. 1

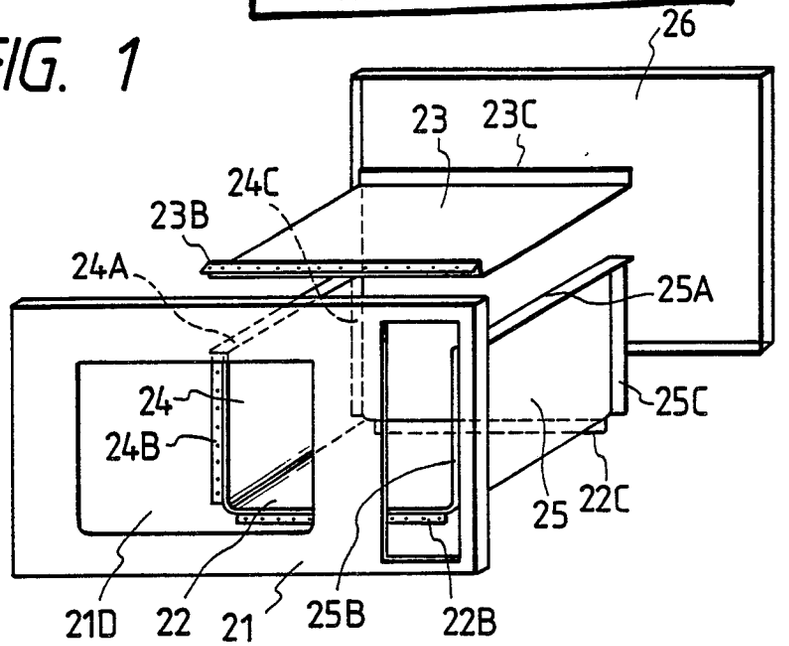


FIG. 2

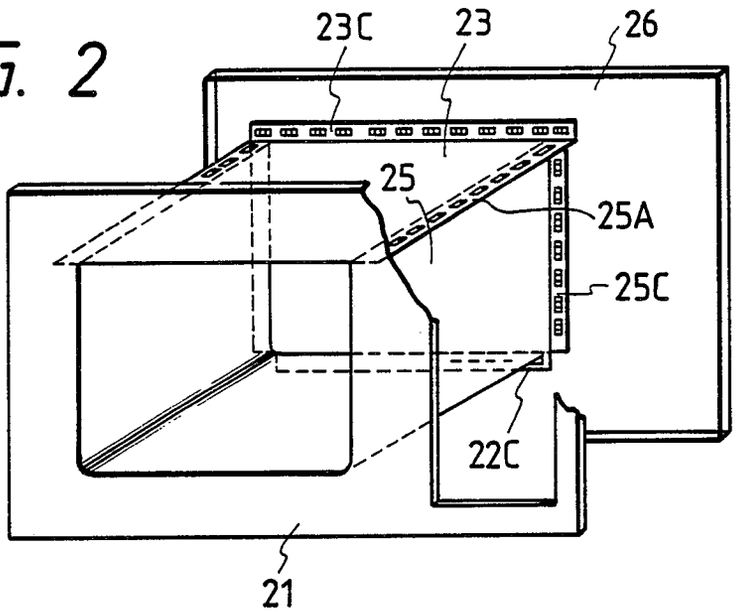


FIG. 3

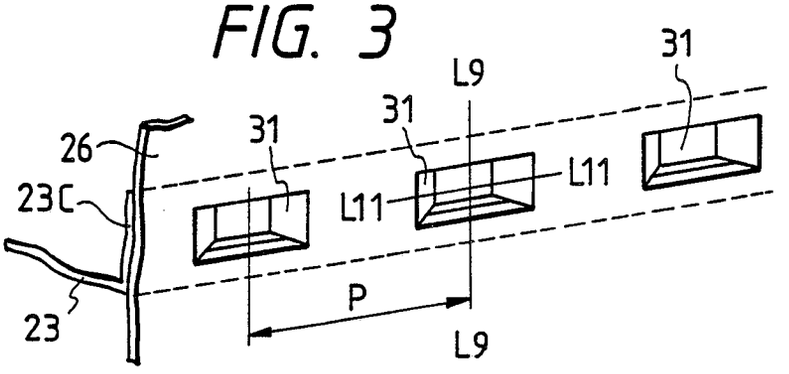


FIG. 4

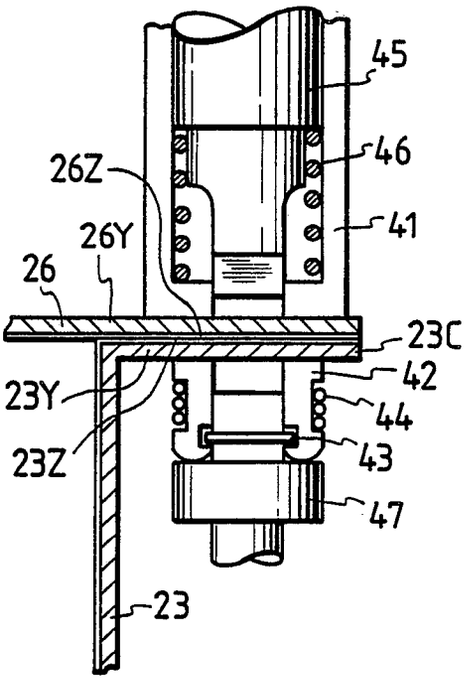


FIG. 5

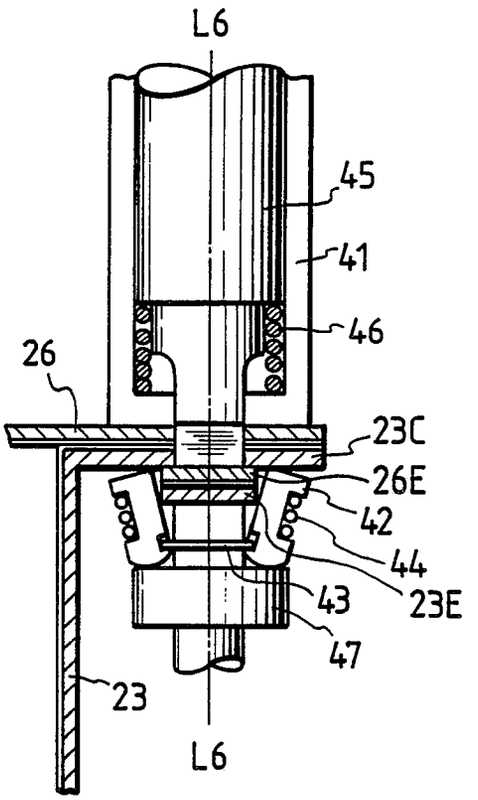


FIG. 6

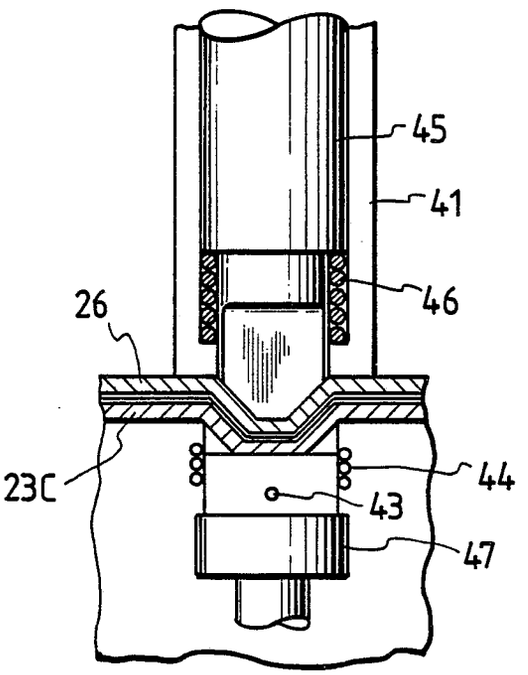


FIG. 7

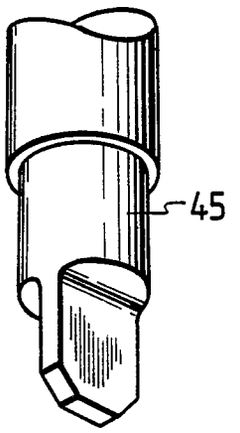


FIG. 8

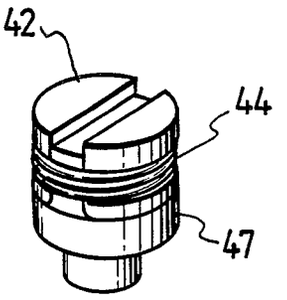


FIG. 9

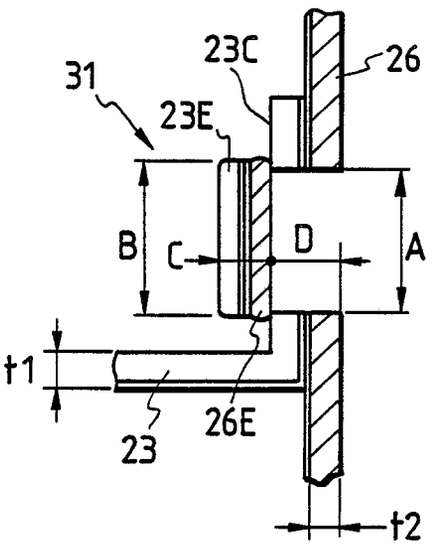


FIG. 10

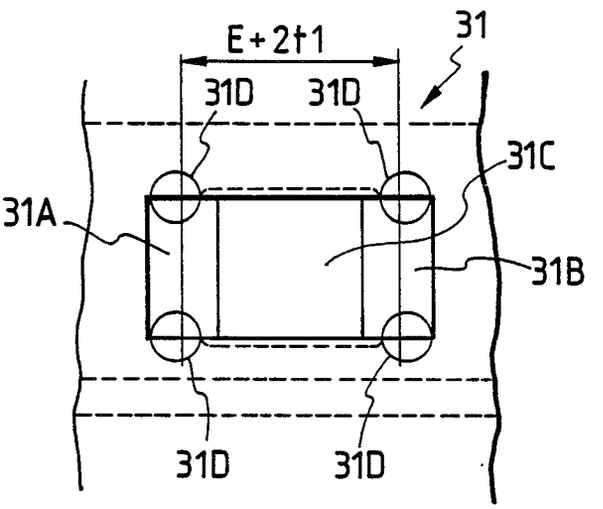


FIG. 11

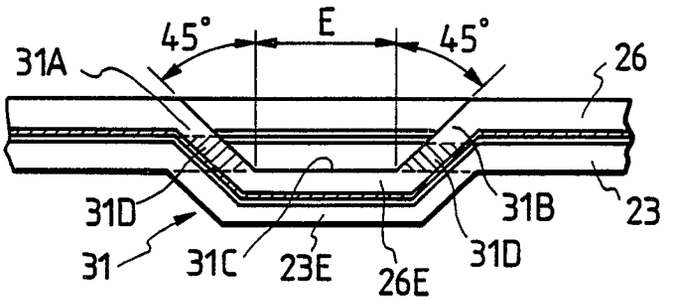


FIG. 12

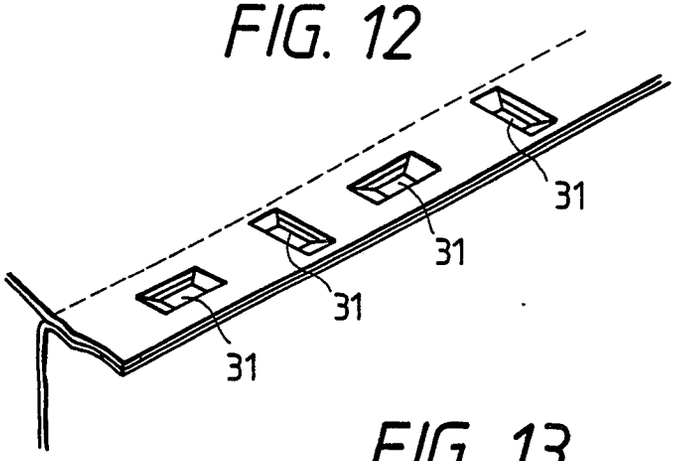


FIG. 13

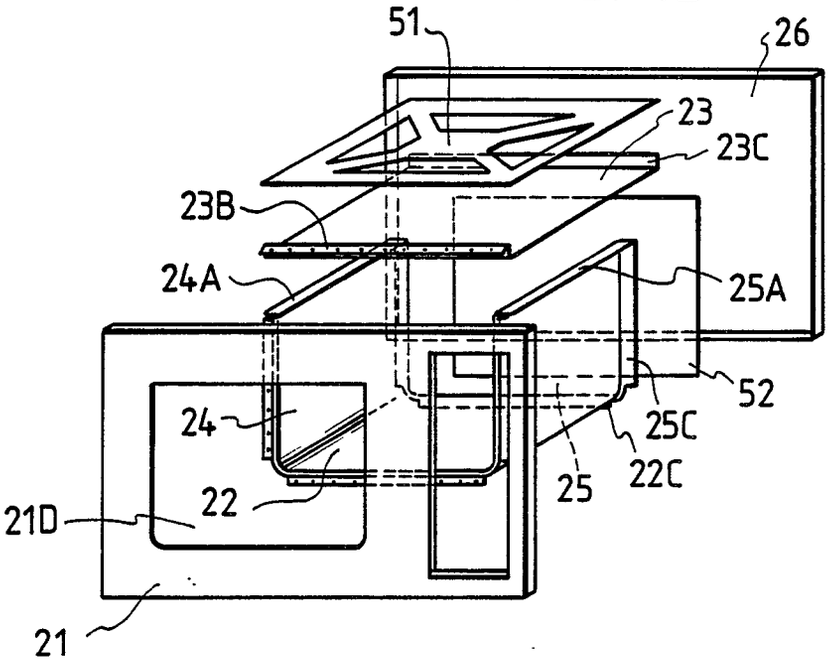


FIG. 14

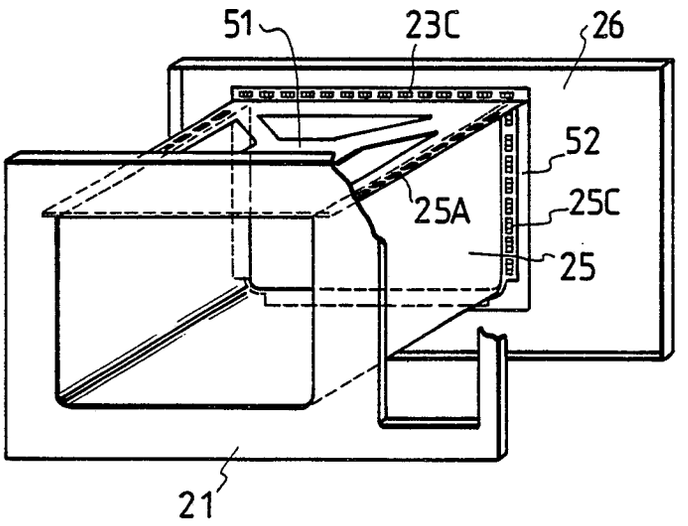


FIG. 15

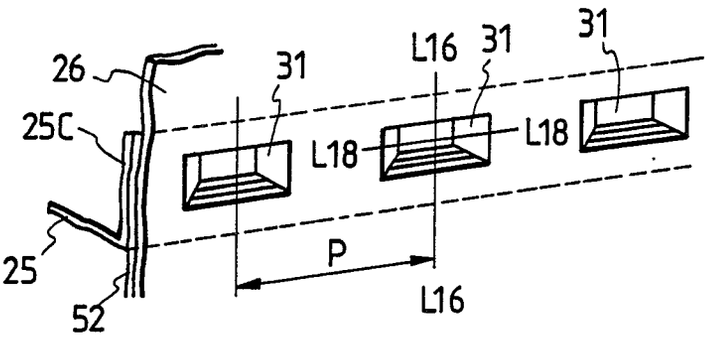


FIG. 16

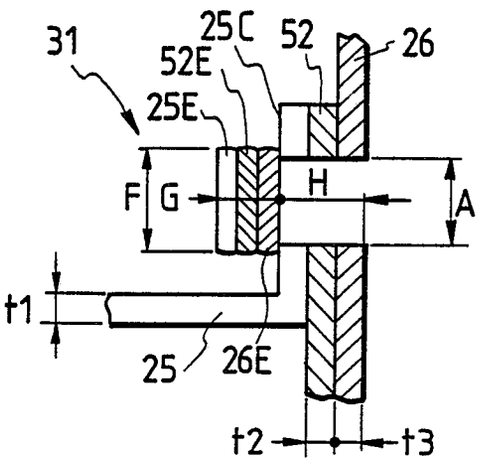


FIG. 17

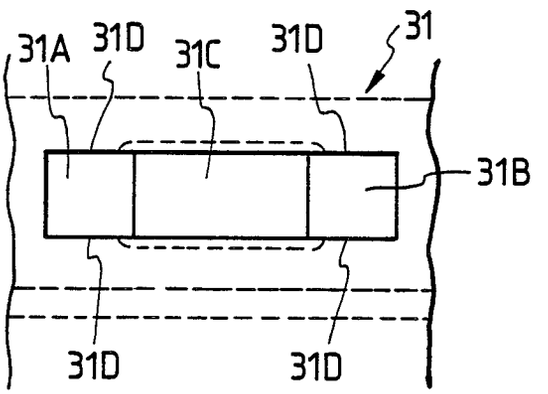


FIG. 18